

Chapter 29

Mojave Basin and Range Ecoregion

By Benjamin M. Sleeter and Christian G. Raumann

This chapter has been modified from original material published in Sleeter and Raumann (2006), entitled “Land-cover trends in the Mojave Basin and Range Ecoregion” (U.S. Geological Survey Scientific Investigations Report 2006–5098).

Ecoregion Description

The Mojave Basin and Range Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997) covers approximately 130,922 km² (50,549 mi²) in the southwestern United States. The ecoregion, which encompasses parts of four states,

includes the Mojave Desert and much of the other desert areas in southeastern California, as well as a large part of the southern Nevada desert (fig. 1). The ecoregion is bounded on the north by the Central Basin and Range Ecoregion, on the east by the Colorado Plateaus and the Arizona/New Mexico Plateau Ecoregions, on the south by the Sonoran Basin and Range Ecoregion, and on the west by the Southern California Mountains and the Sierra Nevada Ecoregions.

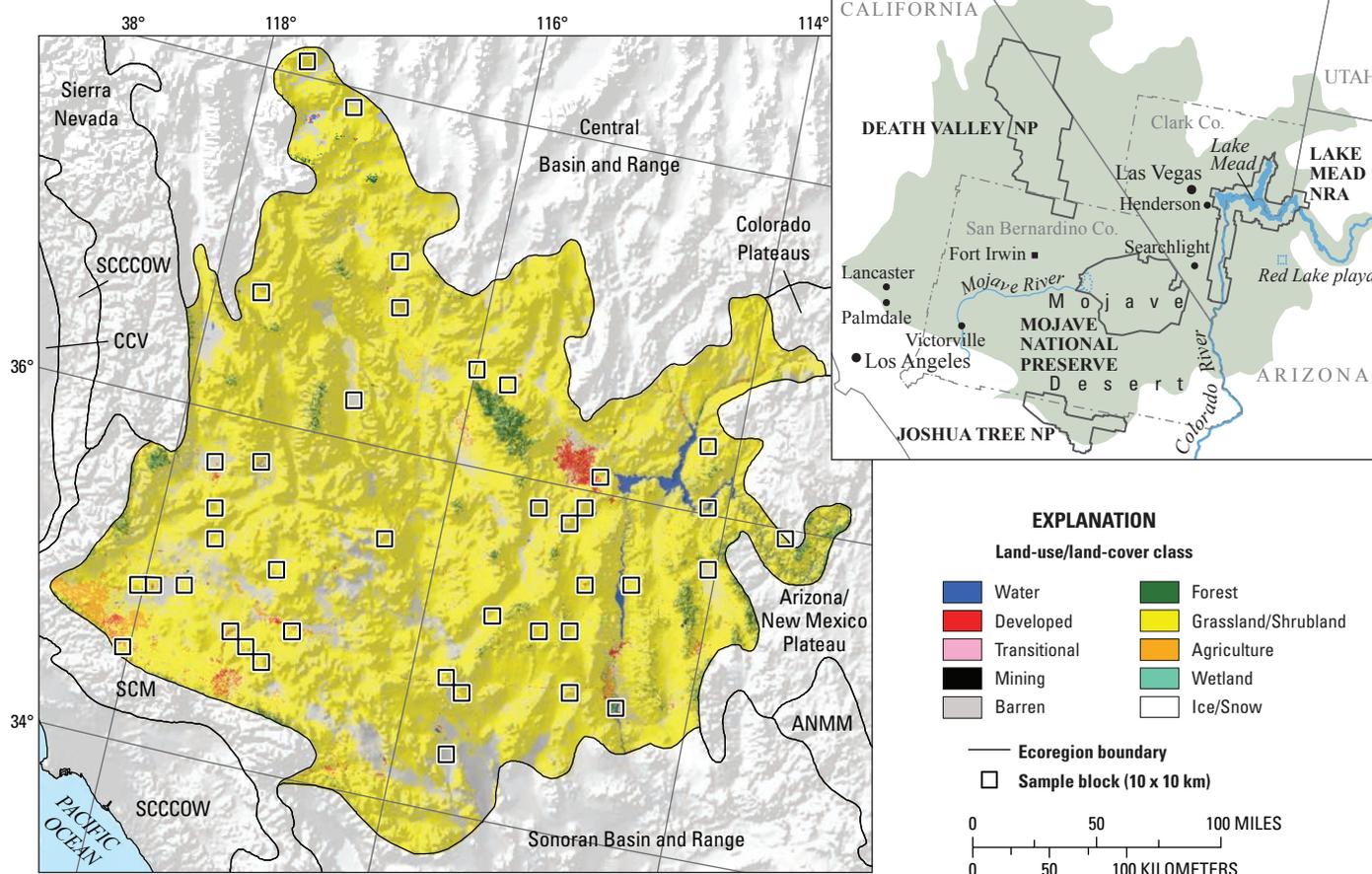
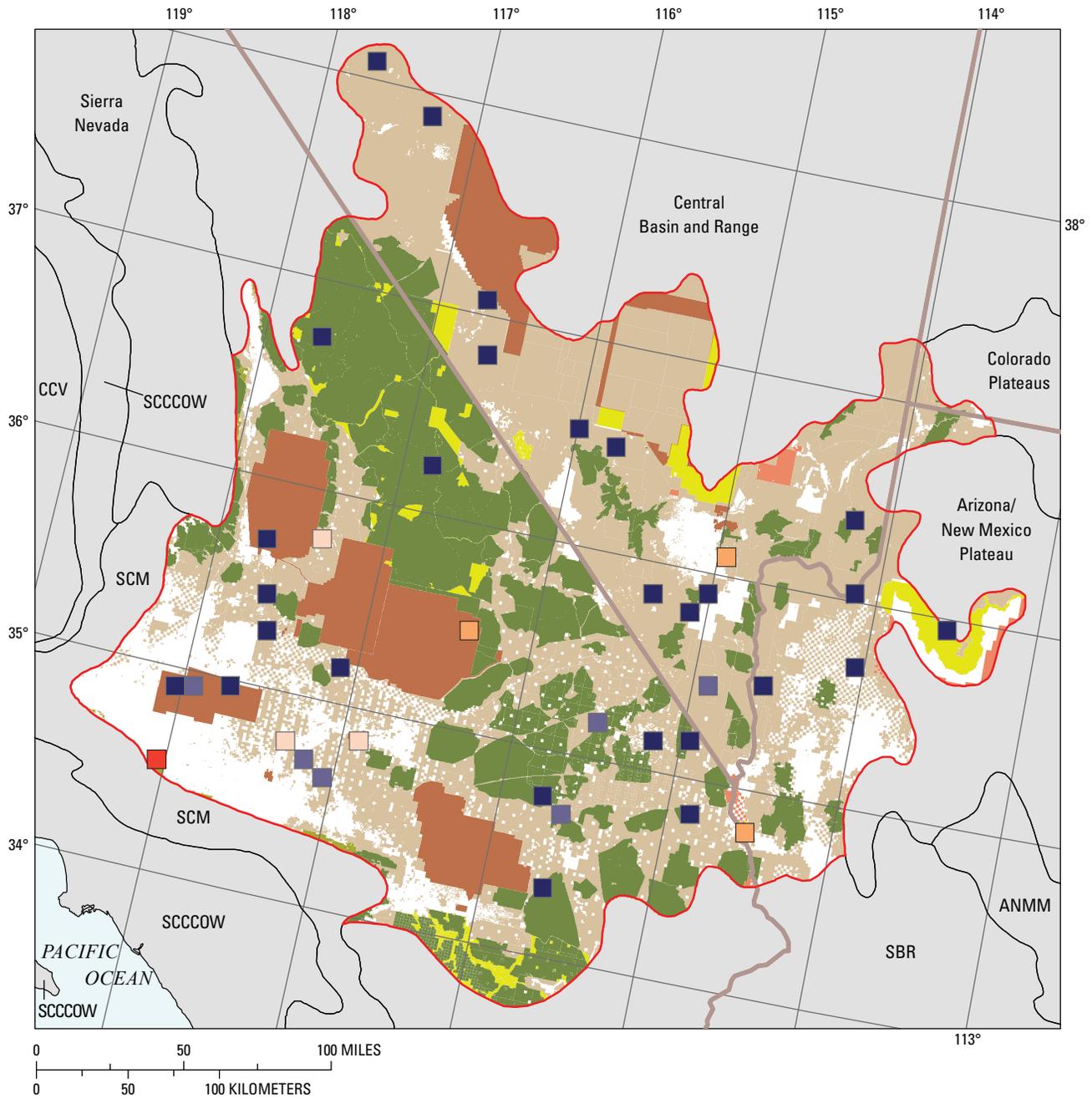


Figure 1. Map of Mojave Basin and Range Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this “Status and Trends of Land Change” study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Squares indicate locations of 10 x 10 km sample blocks analyzed in study. Index map shows locations of geographic features mentioned in text. Abbreviations for Western United States ecoregions are listed in appendix 2. See appendix 3 for definitions of land-use/land-cover classifications.



EXPLANATION		
Federal land-ownership class	Overall spatial change (per 10 x 10 km sample block)	Boundaries
Wilderness Area	0.0–1.0	Mojave Basin and Range Ecoregion
National Forest	1.1–3.0	Other ecoregion
National Monument or Park	3.1–10.0	State boundary
Military land	10.1–20.0	
Tribal lands	20.1–30.3	
Other Federal lands		
Other lands		

Figure 2. Federal land ownership and cumulative land-use/land-cover change (as percent of sample-block area) from 1973 to 2000 in Mojave Basin and Range Ecoregion. Land-ownership data from National Atlas of the United States (2006). See appendix 2 for abbreviations for Western United States ecoregions.



Figure 3. Construction of new hotel, resort, and lake (Lake Las Vegas) outside of Henderson, Nevada.

The Mojave Basin and Range Ecoregion is characterized by distinct fault-bounded mountain ranges that typically run northeast to southwest. The ecoregion receives very little annual precipitation (50–250 mm in the valleys), which, when combined with high temperatures during summer months, results in an ecoregion slow to recover from anthropogenic disturbances (Hunter and others, 2003). Federal lands constitute approximately 81 percent of the total land area (fig. 2), with major holdings under the jurisdiction of the Bureau of Land Management, National Park Service, and Department of Defense. Grasslands and shrublands dominate the ecoregion, whereas developed land accounts for only 1.5 percent of total land area (Vogelmann and others, 2001). Although developed land is limited, the two major urban areas found in the ecoregion are among the fastest growing locales in the western United States. Las Vegas, Nevada, is the major urban center within the ecoregion (fig. 3), although the cities of Palmdale and Lancaster, California, also had significant growth between 1973 and 2000.

The Mojave Basin and Range Ecoregion has long supported human activities such as livestock grazing, mining, military training, and recreation, all of which have had some effect on the desert landscape (Lovich and Bainbridge, 1999). Agriculture, although not extensive, takes place along the Colorado and Mojave Rivers. Mining, which historically has been an important land-use activity, is found throughout the ecoregion wherever mineral resources are available (fig. 4). Recreation activities have become increasingly important in the ecoregion, with millions of people each year visiting Death Valley National Park, Mojave National Preserve, and Lake Mead National Recreation Area, as well as numerous open-access Bureau of Land Management lands (fig. 5).

Contemporary Land-Cover Change (1973 to 2000)

The overall spatial change (that is, the percentage of area that changed at least one time between 1973 and 2000) in the Mojave Basin and Range Ecoregion is estimated at 2.7

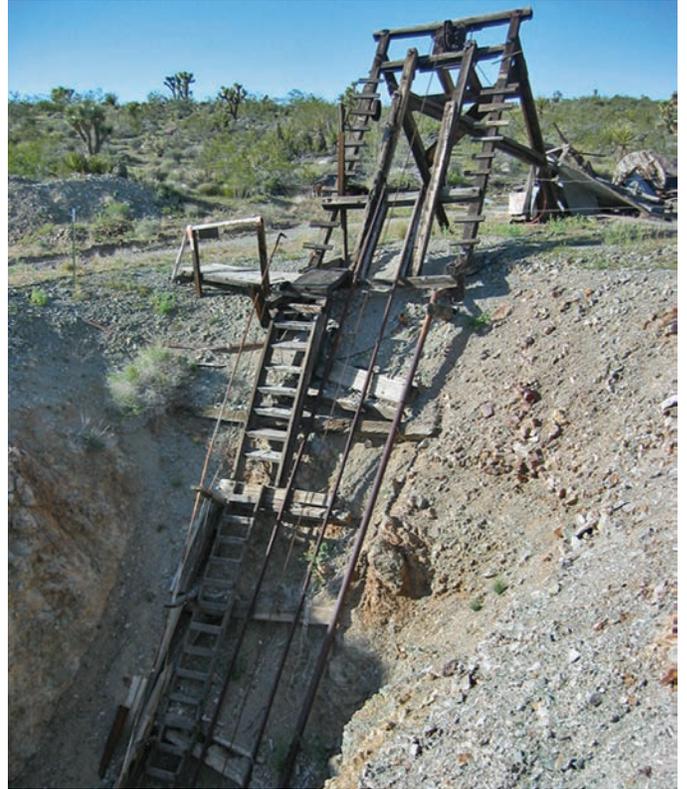


Figure 4. Abandoned mine shaft outside Searchlight, Nevada.



Figure 5. Staging and camping area for off-highway-vehicle users near Red Lake playa, Arizona, located about 30 km south-east of Lake Mead.

percent (3,474 km²), which is low when compared to other western United States ecoregions (fig. 6). The ecoregion also showed low rates of change across all time periods when compared to other western United States ecoregions (fig. 7). The period between 1986 and 1992 had the highest estimated rate of change, at 1.3 percent. In addition, when change estimates are normalized to account for the varying lengths of the time periods, change remained highest between 1986 and 1992, at 0.2 percent per year, whereas the other three time periods (1973–1980, 1980–1986, and 1992–2000) are estimated at 0.07 to 0.08 percent per year (table 2).

The largest change in any one land-cover class was the estimated loss of 2,387 km² of grassland/shrubland, a 2.0

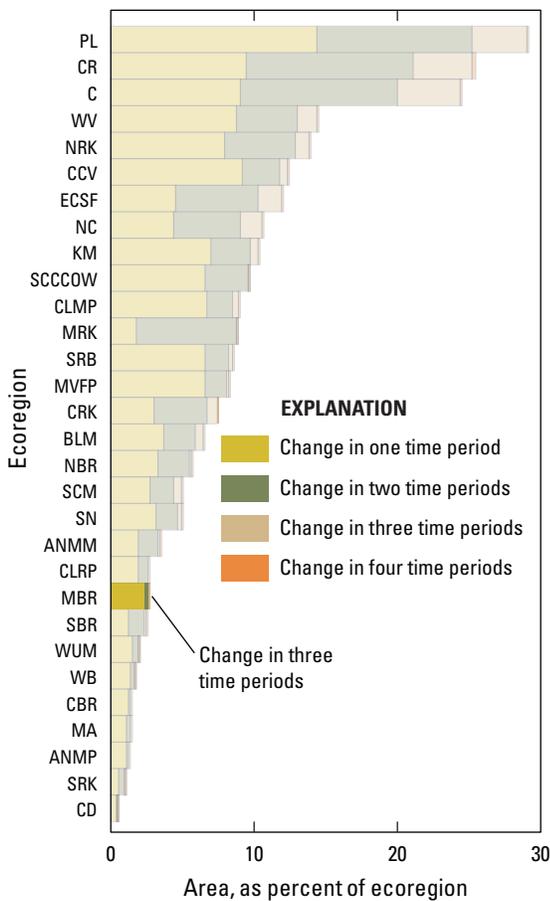


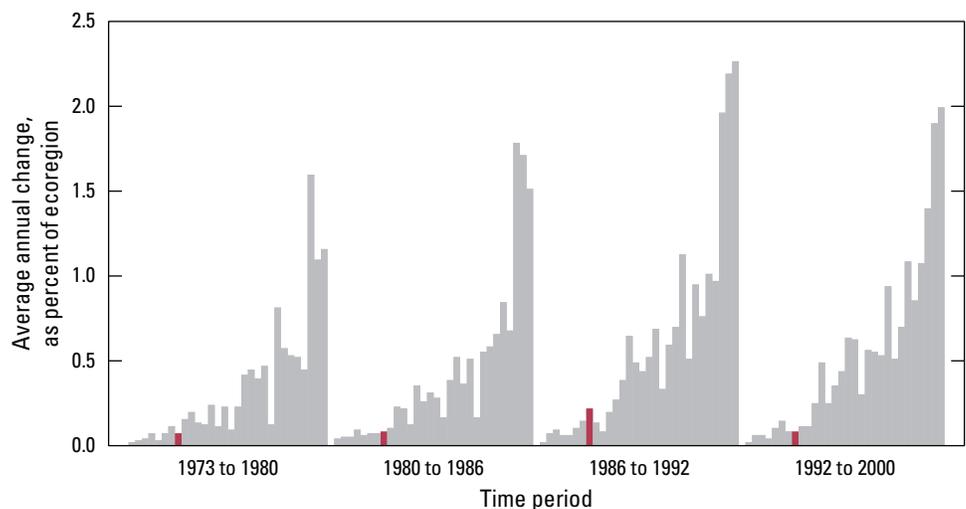
Figure 6. Overall spatial change in Mojave Basin and Range Ecoregion (MBR; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Mojave Basin and Range Ecoregion (three time periods) labeled for clarity. See table 2 for years covered by each time period. See appendix 2 for key to ecoregion abbreviations.

percent decline. In 1973, grassland/shrubland is estimated to account for 89.2 percent of the ecoregion. In 2000, grassland/shrubland accounted for 87.4 percent of the ecoregion. The second largest change was the addition of 1,673 km² of developed land, which increased from 1.5 percent of the ecoregion in 1973 to 2.8 percent of the ecoregion in 2000. Estimates of land-cover composition for all classes for each time period can be found in table 3. Normalized net change values for all classes for each time period can be found in figure 8.

The dominant land-cover change that occurred in the Mojave Basin and Range Ecoregion was the conversion of grassland/shrubland to developed land. An estimated 1,426 km² of grassland/shrubland were converted to developed land between 1973 and 2000, with 52.7 percent (751 km²) converting between 1986 and 1992. Grassland/shrubland converting to mechanically disturbed and mining, forest converting to mechanically disturbed, and mechanically disturbed converting to developed were the other top land-cover conversions between 1973 and 2000 (table 4). Combined, these conversions account for an estimated 78.5 percent of all changes in the ecoregion.

Population growth in the Mojave Basin and Range Ecoregion, much of it spillover from the Los Angeles, California, metropolitan area, was the primary driver of change in the ecoregion. In three of the four time periods (1973–1980, 1980–1986, and 1986–1992), grassland/shrubland converting directly to developed land was the most common conversion and, between 1992 and 2000, the second most common conversion. New developed land was added to the ecoregion at an average rate of 62 km² per year, an estimated total of 1,680 km² over the 27-year study period. Development was not dispersed evenly across the ecoregion. On the basis of field observations, increases in developed land appeared to be concentrated in two main regions, the Las Vegas, Nevada, metropolitan area and the cities of Victorville, Lancaster, and Palmdale, California, in the western

Figure 7. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Mojave Basin and Range Ecoregion are represented by red bars in each time period.



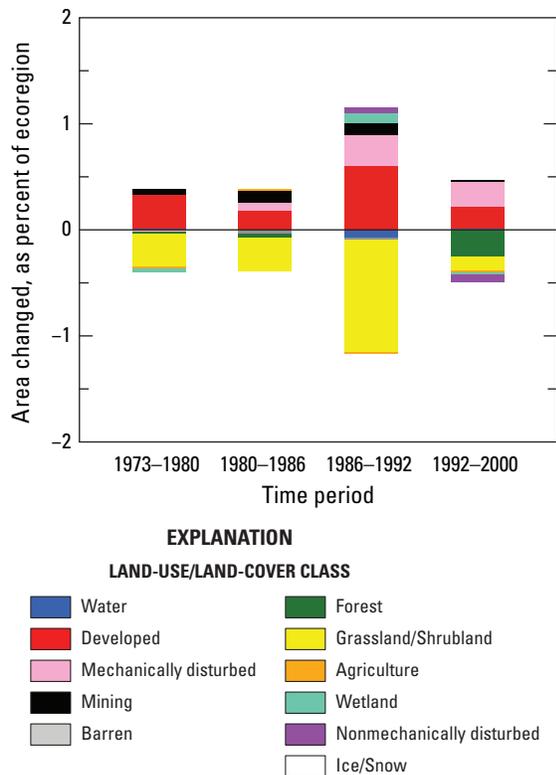


Figure 8. Normalized average net change in Mojave Basin and Range Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

Mojave Desert; Las Vegas is one of the fastest growing cities in the United States, whereas Palmdale and Lancaster both have populations larger than 100,000 (U.S. Census Bureau, 2001). Population statistics show that Clark County, Nevada, added more than 1.3 million residents between 1970 and 2000, whereas San Bernardino County, California, has added more than 1.175 million people during the same time period (fig. 9) (U.S. Census Bureau, 2001). Figure 10 shows land-use/land-cover data for a sample site near Palmdale, California, which has experienced rapid urbanization.

Land ownership is another driving force of land-cover change. As previously noted, the Federal Government owns a large percentage of land within the ecoregion, the largest landholder being the Bureau of Land Management, and each federal agency manages public lands to meet distinct goals and objectives. For instance, Bureau of Land Management lands are often open for public use and recreation such as off-highway-vehicle (OHV) activities (Lovich and Bainbridge, 1999). In most cases, OHV disturbances such as single vehicle tracks were not detected in image interpretations because of the coarse size of the minimum mapping unit (60 m) and are, therefore, not described by the change estimates. However, image interpretations did identify several OHV staging areas where relatively large areas of grassland/shrubland have been gradually stripped of vegetation. Continued use of these areas has resulted in soil compaction, which has prevented the reestablishment of vegetation. The growth of OHV activity in the ecoregion can be attributed largely to the open-access policy of the Bureau of Land Management lands, as well as the close proximity of these lands to major urban areas (Sheridan, 1979).

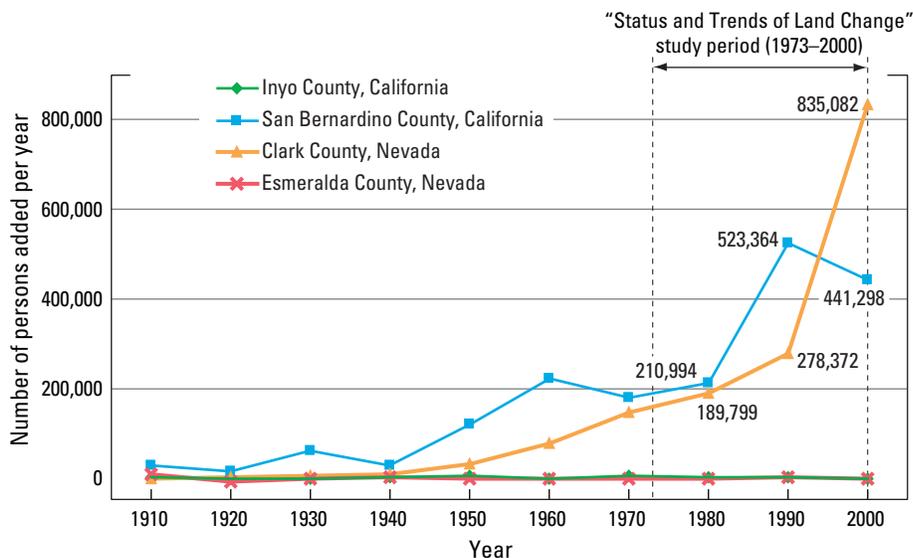


Figure 9. Population trends between 1910 and 2000 of selected counties in Mojave Basin and Range Ecoregion. Numbers of persons added to each county are from U.S. Census data at 10-year intervals (U.S. Census Bureau, 2001). San Bernardino County, California, and Clark County, Nevada, have experienced highest growth of any counties in ecoregion, each adding more than 175,000 persons in each decade since 1980.

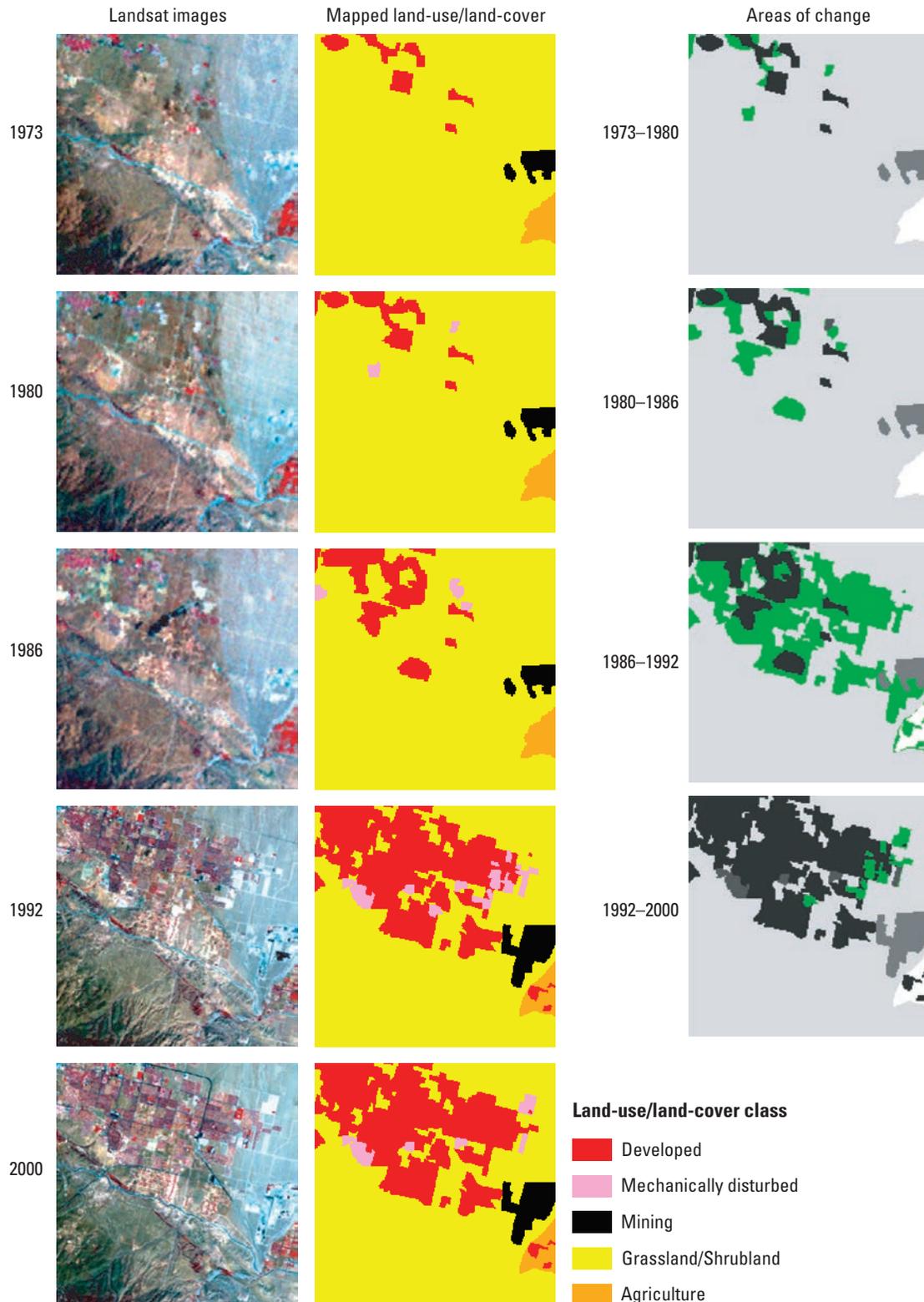


Figure 10. Data for sample block 14-1009, located near Palmdale, California, illustrating urbanization taking place in Mojave Basin and Range Ecoregion. Left column is satellite imagery collected for each of five years analyzed in study, used to map land-use/land-cover change in four time periods between study years (imagery sources for study years: 1973, 1980, and 1986 are Landsat Multispectral Scanner (MSS) images; 1992 is Landsat Thematic Mapper (TM) image; 2000 is Landsat Enhanced Thematic Mapper (ETM) image). Center column is mapped land-use/land-cover data for each study year. Right column shows areas that changed (green areas) in each of four time periods between study years; light- and dark-gray-shaded areas do not change between study years but, rather, represent overall land-use/land-cover footprint throughout study period.



Figure 11. Mechanical disturbance (vehicle tracks) observed at Fort Irwin National Training Center, California, site of intensive military training that includes live-fire exercises.

The Department of Defense has a substantially different mandate pertaining to its land ownership and management policies. The Department of Defense manages vast areas of the ecoregion (fig. 2) for conducting military training activities. The largest of the facilities that lie entirely within the ecoregion is Fort Irwin National Training Center, California (2,369 km²), which is used for desert-warfare training that includes live-fire exercises. Tracked and wheeled vehicles, which operate throughout the facility, can have a major impact on the health and composition of desert flora and fauna (Prose and Wilshire, 2000). Recent studies have estimated that several hundred years will be needed

for desert soils and vegetation to recover once exposed to these intensive land-use practices (Prose and Wilshire, 2000; Steiger and Webb, 2000). This phenomenon was observed in the eastern part of Fort Irwin, which was heavily used for tracked- and wheeled-vehicle operations training (fig. 11). Evidence of this destruction includes compacted and rutted soils, low shrub density, and stunted growth of creosote bush (*Larrea tridentata*) and other vegetation.

Unlike the Bureau of Land Management and Department of Defense, the National Park Service attempts to preserve natural desert lands while promoting low-impact public recreation such as camping, hiking, and sightseeing. The largest holding of the National Park Service within the ecoregion is Death Valley National Park (12,759 km²). Other National Park Service areas include Mojave National Preserve and Joshua Tree National Park. With the exception of small, tourism-supported development such as visitor centers, boardwalks, campgrounds, hiking trails, and unimproved roads, no land-cover changes were detected on National Park Service lands, further illustrating the significant role that land-ownership and -management goals play in regards to the spatial distribution of contemporary land-cover change.

Results show that change between land-cover classes in the Mojave Basin and Range Ecoregion is relatively rare and highly localized. Urbanization is the primary source of change, although other human-use activities such as military training and recreation are significant contributors to change within the ecoregion.

Table 1. Percentage of Mojave Basin and Range Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (97.3 percent), whereas 2.7 percent changed at least once throughout study period. Two dashes (--) indicate that, because zero pixels changed four times during study period, relative error is not calculable]

Number of changes	Percent of ecoregion	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	2.4	1.3	1.1	3.8	0.9	37.0
2	0.2	0.1	0.1	0.3	0.1	45.9
3	0.0	0.0	0.0	0.0	0.0	98.5
4	0.0	0.0	0.0	0.0	0.0	--
Overall spatial change	2.7	1.4	1.2	4.1	1.0	36.5

Table 2. Raw estimates of change in Mojave Basin and Range Ecoregion land cover, computed for each of four time periods between 1973 and 2000, and associated error at 85-percent confidence level.

[Estimates of change per period normalized to annual rate of change for each period]

Period	Total change (% of ecoregion)	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
Estimate of change, in percent stratum							
1973–1980	0.5	0.3	0.2	0.8	0.2	37.0	0.1
1980–1986	0.5	0.2	0.2	0.7	0.2	36.4	0.1
1986–1992	1.3	0.9	0.3	2.2	0.6	50.6	0.2
1992–2000	0.6	0.5	0.2	1.1	0.3	50.5	0.1
Estimate of change, in square kilometers							
1973–1980	675	366	308	1,041	250	37.0	96
1980–1986	605	323	282	928	220	36.4	101
1986–1992	1,660	1,232	428	2,892	839	50.6	277
1992–2000	841	624	217	1,466	425	50.5	105

Table 3. Estimated area (and margin of error) of each land-cover class in Mojave Basin and Range Ecoregion, calculated five times between 1973 and 2000. See appendix 3 for definitions of land-cover classifications.

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grassland/ Shrubland		Agriculture		Wetland		Non- mechanically disturbed	
	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-
Area, in percent stratum																				
1973	0.9	0.9	1.5	0.9	0.1	0.1	1.1	1.2	4.7	3.9	2.0	1.6	89.2	4.6	0.2	0.2	0.3	0.3	0.0	0.0
1980	0.9	0.9	1.8	1.0	0.1	0.1	1.1	1.2	4.7	3.9	2.0	1.6	88.9	4.6	0.2	0.2	0.2	0.3	0.0	0.0
1986	0.9	0.9	2.0	1.0	0.2	0.1	1.3	1.3	4.7	3.9	1.9	1.6	88.6	4.6	0.2	0.2	0.2	0.3	0.0	0.0
1992	0.8	0.9	2.6	1.4	0.5	0.4	1.4	1.4	4.7	3.9	1.9	1.6	87.5	4.7	0.2	0.2	0.3	0.4	0.1	0.1
2000	0.9	0.9	2.8	1.5	0.7	0.6	1.4	1.4	4.7	3.9	1.7	1.5	87.4	4.7	0.2	0.2	0.3	0.4	0.0	0.0
Net change	0.0	0.1	1.3	1.0	0.6	0.6	0.3	0.2	-0.1	0.1	-0.3	0.4	-1.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Gross change	0.2	0.2	1.3	1.0	0.8	0.6	0.3	0.2	0.1	0.1	0.3	0.4	2.0	1.3	0.1	0.1	0.1	0.2	0.1	0.2
Area, in square kilometers																				
1973	1,164	1,183	1,958	1,184	152	104	1,394	1,604	6,196	5,097	2,581	2,119	116,844	5,984	303	270	331	419	0	0
1980	1,198	1,209	2,349	1,263	124	96	1,482	1,627	6,196	5,096	2,570	2,113	116,430	6,001	277	243	296	370	0	0
1986	1,198	1,209	2,594	1,303	216	185	1,638	1,707	6,153	5,094	2,522	2,097	116,013	5,991	293	250	296	370	0	0
1992	1,108	1,123	3,386	1,784	609	587	1,776	1,777	6,123	5,093	2,520	2,106	114,622	6,096	287	250	408	530	82	118
2000	1,139	1,140	3,638	1,908	925	790	1,813	1,783	6,123	5,093	2,189	1,903	114,457	6,150	270	228	369	474	0	0
Net change	-25	106	1,680	1,329	773	745	418	281	-73	110	-392	493	-2,387	1,646	-33	50	38	55	0	0
Gross change	224	274	1,680	1,329	1,073	785	422	281	93	109	417	528	2,611	1,649	73	67	185	267	163	236

Table 4. Principal land-cover conversions in Mojave Basin and Range Ecoregion, showing amount of area changed (and margin of error, calculated at 85-percent confidence level) for each conversion during each of four time periods and also during overall study period. See appendix 3 for definitions of land-cover classifications.

[Values given for “other” class are combined totals of values for other land-cover classes not listed in that time period. Abbreviations: n/a, not applicable]

Period	From class	To class	Area changed (km ²)	Margin of error (+/- km ²)	Standard error (km ²)	Percent of ecoregion	Percent of all changes
1973–1980	Grassland/Shrubland	Developed	314	241	164	0.2	46.5
	Grassland/Shrubland	Mining	90	94	64	0.1	13.3
	Mechanically disturbed	Developed	52	56	38	0.0	7.7
	Wetland	Water	34	50	34	0.0	5.1
	Barren	Grassland/Shrubland	34	49	34	0.0	5.0
	Other	Other	151	n/a	n/a	0.1	22.4
	Totals		675			0.5	100.0
1980–1986	Grassland/Shrubland	Developed	202	192	131	0.2	33.3
	Grassland/Shrubland	Mechanically disturbed	115	132	90	0.1	19.0
	Grassland/Shrubland	Mining	110	103	70	0.1	18.1
	Barren	Mining	49	70	48	0.0	8.0
	Mechanically disturbed	Developed	38	35	24	0.0	6.2
	Other	Other	92	n/a	n/a	0.1	15.3
Totals		605			0.5	100.0	
1986–1992	Grassland/Shrubland	Developed	751	851	580	0.6	45.2
	Grassland/Shrubland	Mechanically disturbed	435	421	287	0.3	26.2
	Water	Wetland	125	180	123	0.1	7.5
	Grassland/Shrubland	Mining	110	97	66	0.1	6.6
	Grassland/Shrubland	Nonmechanically disturbed	82	118	80	0.1	4.9
	Other	Other	158	n/a	n/a	0.1	9.5
Totals		1,660			1.3	100.0	
1992–2000	Forest	Mechanically disturbed	324	467	318	0.2	38.5
	Grassland/Shrubland	Developed	160	183	124	0.1	19.1
	Mechanically disturbed	Developed	89	80	54	0.1	10.5
	Nonmechanically disturbed	Grassland/Shrubland	82	118	80	0.1	9.7
	Grassland/Shrubland	Mechanically disturbed	77	58	40	0.1	9.1
	Other	Other	110	n/a	n/a	0.1	13.1
Totals		841			0.6	100.0	
1973–2000 (overall)	Grassland/Shrubland	Developed	1,426	1,191	811	1.1	37.7
	Grassland/Shrubland	Mechanically disturbed	651	591	403	0.5	17.2
	Grassland/Shrubland	Mining	345	245	167	0.3	9.1
	Forest	Mechanically disturbed	340	488	332	0.3	9.0
	Mechanically disturbed	Developed	205	138	94	0.2	5.4
	Other	Other	814	n/a	n/a	0.6	21.5
Totals		3,781			2.9	100.0	

References Cited

- Hunter, L.M., Gonzalez, M. de J., Stevenson, M., Karish, K.S., Toth, R., Edwards, T.C., Lillieholm, R.J., and Cablk, M., 2003, Population and land use change in the California Mojave; natural habitat implications of alternative futures: *Population Research and Policy Review*, v. 22, p. 373–379.
- Lovich, J.E., and Bainbridge, D., 1999, Anthropogenic degradation of the southern California desert ecosystem and prospects for natural recovery and restoration: *Environmental Management*, v. 24, p. 309–326.
- National Atlas of the United States, 2006, Federal Lands of the United States: National Atlas of the United States database, accessed February 19, 2006, at <http://nationalatlas.gov>.
- Omernik, J.M., 1987, Ecoregions of the conterminous United States: *Annals of the Association of American Geographers*, v. 77, no. 1, p. 118–125.
- Prose, D.V., and Wilshire, H.G., 2000, The lasting effects of tank maneuvers on desert soils and intershrub flora: U.S. Geological Survey Open-File Report 00–512, 22 p., accessed at <http://geopubs.wr.usgs.gov/open-file/of00-512/>.
- Sheridan, D., 1979, Off-road vehicles on public land: Council on Environmental Quality, 84 p.
- Sleeter, B.M., and Raumann, C.G., 2006, Land-cover trends in the Mojave Basin and Range Ecoregion: U.S. Geological Survey Scientific Investigations Report 2006–5098, 18 p., accessed at <http://pubs.usgs.gov/sir/2006/5098/>.
- Steiger, J.W., and Webb, R.H., 2000, Recovery of perennial vegetation in the military target sites in the eastern Mojave Desert, Arizona: U.S. Geological Survey Open-File Report 00–355, 28 p., accessed at <http://geopubs.wr.usgs.gov/open-file/of00-355/>.
- U.S. Census Bureau, 2001, American Fact Finder: U.S. Census Bureau database, accessed May 1, 2005, at http://factfinder.census.gov/home/saff/main.html?_lang=en.
- U.S. Environmental Protection Agency, 1997, Descriptions of level III ecological regions for the CEC report on ecological regions of North America: U.S. Environmental Protection Agency database, accessed April 12, 2006, at http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads.
- Vogelmann, J.E., Howard, S.M., Yang, L., Larson, C.R., Wylie, B.K., and van Driel, N., 2001, Completion of the 1990s National Land Cover Data Set for the conterminous United States from Landsat Thematic Mapper data and ancillary data sources: *Photogrammetric Engineering & Remote Sensing*, v. 67, p. 650–662.